Mojoli et al. Intensive Care Medicine Experimental 2015, 3(Suppl 1):A998
http://www.icm-experimental.com/content/3/S1/A998

Intensive Care Medicine Experimental
a SpringerOpen Journal

POSTER PRESENTATION Open Access

Automatic monitoring of plateau and driving pressure during pressure and volume controlled ventilation

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From ESICM LIVES 2015
Berlin, Germany. 3-7 October 2015

Introduction

Plateau pressure (Pplat) limitation is routinely used to avoid ventilator-induced lung injury. Recently, driving pressure (ΔP) was strongly associated with survival in ARDS patients [1].

Objectives

To evaluate the feasibility of ΔP and Pplat continuous monitoring during volume (VCV) and pressure (PCV) controlled ventilation, we compared with gold standard (occlusion maneuvers at end-inspiration and end-expiration) two different methods: 1- Least Square Fitting (LSF) method that provide maneuver-free Pplat and ΔP values; 2- Mini Occlusion (MO) method by performing brief occlusion maneuvers.

Methods

We enrolled 22 patients admitted to our ICU after scheduled major abdominal surgery, with normal or restrictive respiratory system mechanics under pressure (12 pts) and volume (10 pts) controlled mechanical ventilation (G5, Hamilton Medical). We studied 12 different conditions in each patient by changing respiratory rate (10-15-20-25 bpm) and I:E ratio (1:2, 1:1, 2:1). Inspiratory pressure in PCV and tidal volume (TV) in VCV were adjusted to keep end-tidal CO_2 between 32 and 36 mmHg. PEEP and FiO_2 were set to maintain $SpO_2 \geq 95\%$. ΔP, Pplat and PEEPtot reference values (ΔP_{REF}, $Pplat_{REF}$ and $PEEPtot_{REF}$) for each ventilatory setting were obtained by 5s-length occlusion maneuvers at end-inspiration and end-expiration ($\Delta P_{REF} = Pplat_{REF} - PEEPtot_{REF}$). ΔP_{MO} values were calculated as: $Pplat_{MO} - PEEPtot_{MO}$, $Pplat_{MO}$ and $PEEPtot_{MO}$ being average airway pressure in the last 100 ms of mini-occlusion maneuvers lasting 400 ms. LSF applied over the whole respiratory cycle provided $Pplat_{LSF}$ and Crs_{LSF} values, being Crs the compliance of the respiratory system. ΔP_{LSF} was calculated as TV/Crs_{LSF}.

Results

Difference with reference values was greater for MO vs. LSF, both for ΔP (0.82 ± 0.41 vs. 0.46 ± 0.82 cmH_2O, respectively; $p < 0.001$) and Pplat (0.52 ± 0.33 vs. 0.02 ± 0.49 cmH_2O; $p < 0.001$).

Conclusions

Both methods provided a good estimation of ΔP and Pplat; MO showed a slightly better precision than LSF, but a greater bias, being these differences not clinically relevant. Anyway, LSF is a totally continuous and non invasive method, whereas MO method minimally interferes with mechanical ventilation and its implementation on ICU ventilators could be more troublesome.

Published: 1 October 2015

Reference

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doi:10.1186/2197-425X-3-S1-A998
Cite this article as: Mojoli *et al.*: Automatic monitoring of plateau and driving pressure during pressure and volume controlled ventilation. *Intensive Care Medicine Experimental* 2015 **3**(Suppl 1):A998.

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